# MONITORING SYSTEM

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention relates to a system for monitoring a remote subject and more particularly to a system for ascertaining an out of boundary condition and transmitting to a central station information pertaining to the condition as well as the location of the subject.

### 2. Antecedent History

Various monitoring devices for promotion of safety and security of persons and property have been described in United States Patent 5,825,283 entitled System for the Security and Auditing of Persons and Property, issued to Applicant herein on October 20, 1998 and incorporated herein by reference.

While the previously known monitoring systems were capable of ascertaining the physical location of a subject as well as monitoring the status of vehicular functions and the like, e.g. U.S. Patent 5,450,321, and were further capable of reducing the number of out of boundary condition reports by, for example, providing a time window within which an out of boundary condition may be corrected, as illustrated in Patent 5,430,432 entitled

Automotive Warning and Recording System, issued July 4, 1995 to Applicant herein, there was a perceived need to provide a monitoring system capable of both monitoring a physiological parameter condition associated with the subject and thereafter conveying information pertaining to such condition as well as identifying the specific location of the subject for initiating corrective action.

## SUMMARY OF THE INVENTION

A processor implemented monitoring system includes a mobile unit comprising a sensor capable of monitoring, on a continuous, predetermined interval or random basis, a physiological parameter of a subject such as heart function, e.g. blood pressure, pulse, blood oxygen level, as well as unique subject identifying physiological parameters such as DNA characteristics obtained from sampling of blood or other fluids such as saliva, perspiration, etc., a retinal scan, a fingerprint scan, voice recognition and the like, coupled with a location ascertaining system, e.g. a GPS system. The mobile unit is coupled via radio, cellular telephone or other wireless or wired communications link with a central station.

The system may be employed to determine, for example, whether an operator of specified equipment is an authorized individual by sampling the identifying physiological parameter and comparing the sampled data with boundary data stored in a processor memory. If an off-limit physiological parameter is detected, e.g. a truck driver has been driving for more than the permitted hours, the monitoring system communicates with the central station to identify the off limit condition and specify the geographic location of the subject for the purpose of summoning help or alerting the proper authorities.

Optionally the physiological parameter boundary data may be stored in a memory at a remote location, e.g. the central station; a central station processor receives the sampling data and determines if an off limit condition exists.

The central station is also capable of signaling the monitoring system processor to implement a corrective action output device such as a vehicle disabling device or, if the monitored parameter is a medical parameter, actuating an implanted pump or transdermal patch for the administration of medication, or other appropriate devices capable of providing assistance in alleviating the emergency physiological condition detected. The processor is also capable for actuating the corrective action output device on its own initiative.

The monitoring system may also be implemented in conjunction with the transport of persons in need of supervision, such as children, handicapped and elderly people on a school bus, ambulette, passenger van, etc.

It should be understood that the terms "student, child and children" as employed hereinafter should be interpreted to encompass elderly, handicapped and any other persons in need of supervision, the terms "school bus" and "vehicle" should be interpreted to include any vehicle or other mode of group transport and the terms "parent and guardian" should be interpreted to include any persons having a supervisory capacity or responsibility for the whereabouts or well being of the child.

The monitoring system may be carried on the bus and ascertains the identity of each child entering the bus for verification of children boarding. The processor then signals the central station when the bus enters the geographic region of a child's bus stop, for example, and the central station thereafter telephones the parent or guardian advising that the child is about to be dropped off. The system also identifies the child when leaving the bus to verify that all children left at their designated stops.

Further implementation, in conjunction with transport of children, is to signal the central station upon each child's

entering the bus with the central station telephoning the parent or guardian to confirm that their child is on the bus or the parent accessing such information by telephoning the central station.

From the foregoing compendium, it will be appreciated that it is an aspect of the present invention to provide a monitoring system of the general character described which is not subject to the disadvantages of the antecedent history aforementioned.

It is a feature of the present invention to provide a monitoring system of the general character described which monitors a physiological parameter of a subject, ascertains the location of the subject and transfers information to a central station when the monitored parameter or location are out of predetermined boundary limits.

A consideration of the present invention is to provide a monitoring system of the general character described which monitors a unique identity parameter of a subject and ascertains the location of the subject for verification of the subject's whereabouts.

Another aspect of the present invention is to provide a monitoring system of the general character described which is capable of administering corrective action in the event a monitored parameter is out of its boundary limit.

A further feature of the present invention is to provide a monitoring system of the general character described which is capable of administering medication when a monitored medical status parameter of a subject is out of normal boundary limits.

Another aspect of the present invention to provide a monitoring system of the general character described which monitors a physiological parameter of a subject, ascertains the location of the subject and transfers information to a central station for a determination when the monitored parameter is out of a predetermined boundary limit.

A further consideration of the present invention is to provide a monitoring system of the general character described for auditing school bus occupancy.

Another aspect of the present invention is to provide a monitoring system of the general character described which is capable of communicating with parents or guardians to advise them when a school bus is about to discharge their child at a bus stop.

A still further feature of the present invention is to provide a monitoring system of the general character described which assures that only authorized personnel are operating monitored equipment.

Yet another consideration of the present invention is to provide a monitoring system of the general character described which ascertains the identity of vehicle operators and precludes an operator from operating a vehicle under unsafe conditions, such as exceeding a prescribed number of operating hours without sleep.

Another aspect of the present invention is to provide a monitoring system of the general character described which provides a sense of security and well being to those in need of supervision and to those responsible for the well being of such persons.

Other aspects, features and considerations of the present invention in part will be obvious and in part will be pointed out hereinafter.

With these ends in view, the invention finds embodiment in various combinations of elements, arrangements of parts and series of steps by which the above-mentioned aspects, features and considerations and certain other aspects, features and considerations are attained, or with reference to the accompanying drawings and the scope of which will be more particularly pointed out and indicated in the appended claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings in which are shown, some of the various possible exemplary embodiments of the invention:

FIG. 1 is a simplified block diagram illustrating a monitoring system constructed in accordance with and embodying the invention and showing a processor interconnected to a central station through a communications link, with processor peripherals including a location determining device and a sensor and with the processor being in communication with an output device for controlling the operation thereof;

FIG. 2 is a schematized block diagram of a monitoring system constructed in accordance with and embodying the invention configured for monitoring the whereabouts of an individual who is restricted to or proscribed from specified geographic locations;

FIG. 3 is a schematized block diagram of a monitoring system constructed in accordance with and embodying the invention in a configuration for monitoring an operator of potentially dangerous or hazardous equipment;

FIG. 4 is a schematized block diagram of a monitoring system constructed in accordance with and embodying the invention

configured for monitoring the medical status of a subject and for summoning assistance as well as the administration of corrective aid; and

FIG. 5 is a schematized block diagram of a monitoring system constructed in accordance with and embodying the invention configured for monitoring the student occupancy of a school bus and communicating with parents or guardians concerning the whereabouts of their children.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now in detail to the drawings, the reference numeral 10 denotes generally a monitoring system constructed in accordance with and embodying the invention. The system 10 includes a processor 12 and an associated memory 14.

Input peripherals such as a location determining device 16, e.g. a GPS based unit, and a sensor 18 are also coupled to the processor 12. A further peripheral such as an output device 20 operates under the control of the processor.

In accordance with the invention, the processor 12 is in communication with a central station 22 through a communications link 24.

Typical components suitable for employment as the processor 12, the memory 14, the location determining device 16, the sensor 18, the output device 20 and the communications link 24 are described in detail in U.S. Patent 5,825,283, which has been incorporated herein by reference.

Pursuant to the invention, the sensor 18 monitors a physiological parameter of a human or animal subject such as blood pressure, pulse, etc. and/or a subject identification physiological parameter such as DNA characteristics obtained from a bodily fluid sample, a retinal scan, a fingerprint scan, voice recognition, visual scan image recognition of facial features, etc.

The sensor 18 and the location determining device 16 input information relating to the monitored parameter and the specific location of the subject respectively to the processor 12. The processor 12 thereafter accesses the memory 14 to ascertain whether or not the monitored physiological parameter data and/or the location data falls within predetermined limits of stored physiological parameter boundary data and stored geographic location boundary data.

In the event either or both types of input data do not fall within the stored boundary limits, the processor 12 generates a signal for initiating corrective action and a signal representative

of the specific geographic location of the subject to a central station 22 through the communications link 24.

The processor 12 is capable of initiating corrective action through the output device 20 upon receipt of an appropriate signal from the central station 22 or upon its own initiative. The processor 12 is also programmed to store the monitored data readings in the memory 14 for later review.

The processor 12 can be programmed to constantly or periodically transmit the sensor and location determining device input data directly to the central station 22 through the communications link 24. In such instance, a central station processor 26 accesses a memory 28 in which are stored the physiological parameter boundary data and geographic location boundary data limits.

FIG. 2 illustrates an embodiment of the invention suitable for monitoring an individual who is confined to or restricted from certain geographic areas, such as a person under house arrest, a person subject to a protective order or an individual who is restricted pursuant to a limited release program, on bail or parole. In this embodiment, like numerals have been employed to denote like components as the FIG. 1 embodiment, however, bearing the suffix "a".

In the FIG. 2 embodiment, a monitoring system 10a includes a processor 12a having an associated memory 14a. Coupled to the processor 12a is a location determining device 16a, a sensor 18a and an output device 20a. A central station 22a is interconnected to the processor 12a through a communications link 24a.

The sensor 18a is configured to monitor the identity of the subject as by bodily fluid sampling, retinal scan, fingerprint scan and the like. Preferably, such monitoring is conducted on a random basis so that the subject can not anticipate when the next sampling will be required. The output device 20a may include an annunciator 25a which will advise the subject when to provide a sample for identity verification, however, automatic sampling as by infrared analysis, is also within the preview of the invention. The sensor 18a may additionally monitor the subject for verification that the subject is not in violation of any further restrictions, e.g. alcohol consumption, utilizing a controlled substance, failing to take prescribed medication, etc.

Upon the processor 12a detecting that the subject is beyond his permitted geographic confines through comparison with location data received from the location determining device 16a and the geographic boundaries stored in the memory 14a, the processor may

implement the annunciator 26a to provide an audible or visual warning to the subject simultaneous with or followed by a communication of such out of boundary condition to the central station 22a, in the event the subject does not correct the out of boundary condition within a specified time interval.

Upon the processor 12a determining that the input data from the sensor pertaining to the identification of the subject and/or other physiological parameters such as, the use of a controlled substance, levels of prescribed medication, is not within the boundaries stored within the memory 14a, the processor 12a furnishes such information to the central station 22a, together with data pertaining to the geographic location of the monitoring system. As with the prior embodiment, the parameter boundary data limits may be stored in a memory 28a associated with the central station for access by a central station processor 26a.

The FIG. 3 embodiment of the monitoring system illustrates a configuration for monitoring the operation of potentially dangerous equipment and assures that it is being operated only by authorized operators who are not subject to impairment.

In this embodiment, a monitoring system 10b includes a processor 12b coupled through a communications link 24b to a memory 14b, a location determining device 16b, a sensor 18b, an output device 20b and to a central station 22b.

The memory 14b carries stored boundary data pertaining to the identification of authorized operators of the equipment as well as each authorized operator's logged hours of operation and data pertaining to time of day restrictions on specified operators, e.g. young or night vision impaired operator's restrictions on time of day hours of operation. Also stored in the memory 14b is boundary data pertaining to permitted ranges of physiological parameters representative of unhampered operation of the equipment, such as permitted blood alcohol level, urine analysis levels and other medical status levels.

The processor 12b receives operator physiological parameter data from the sensor 18b and compares such data with the boundary data stored in the memory to ascertain that the operator of the equipment is authorized, has not exceeded his permitted hours of continuous operation, is otherwise authorized to operate and that the operator's monitored physiological parameters are within limits.

In the event an out of boundary condition is detected, the processor conveys such information to the central station 22b, together with the location of the equipment. In this regard, additionally stored in the memory 14b are permitted equipment location boundaries as would be employed, for example, if the equipment were a tractor trailer.

The processor 12b is capable of controlling an output device 20b for implementing corrective action upon its own initiative in the event an out of boundary condition is detected or upon instruction from the central station 22b.

Depicted in FIG. 4 is a further embodiment of the monitoring system configured for implementation in monitoring a subject potentially in need of medical assistance. In this embodiment, like numerals have been employed to denote like components of the prior embodiments, however bearing the suffix "c". A monitoring system 10c includes a processor 12c interconnected to a memory 14c, a location determining device 16c, a sensor 18c and an output device 20c. The processor also communicates with a central station 22c through a communications link 24c.

The monitoring system 10c of this embodiment detects an out of boundary medical parameter condition of a subject, communicates

with a central station 22c in the event such out of boundary condition is detected and provides for administration of corrective medication and/or stimulation for the purpose of alleviating the condition while help is being summoned.

The sensor 18c of this embodiment comprises a medical status sensor for monitoring any one or more of a number of physiological medical parameters such as pulse, blood pressure, EKG, blood sugar, etc. Data signals from the sensor 18c are received at the processor 12c for comparison with permitted boundary limits of the monitored parameters stored in the memory 14c. Upon detection of an out of boundary condition, the processor 12c signals the central station 22c with identification of the out of boundary condition as well as the location of the subject.

Upon signal from the central station 22c or upon its own initiative, the processor 12c can actuate a suitable output device 20c for the administration of corrective medication or corrective action such as actuation of an implanted left ventricular assist system pump, actuation of a transdermal patch, an implanted insulin or other medication dispensing pump, TENS stimulation, etc.

The output device 20c can be actuated while awaiting emergency assistance summoned by the central station 22 and/or continued

monitoring of an out of boundary condition to determine whether the corrective action instituted by the output device will suffice to alleviate the condition without the need for outside assistance.

FIG. 5 illustrates a further embodiment of the invention wherein a monitoring system 10d is configured to monitor the transportation of children on a school bus. In this embodiment, like numerals have been employed to denote like components of the previous embodiments, however, bearing the suffix "d".

The monitoring system 10d includes a processor 12d coupled to a memory 14d, a location determining device 16d, a sensor 18d and an output device 20d. The processor 12d is in communication with a central station 22d through a communications link 24d.

The monitoring system 10d is preferably carried within the transport vehicle, in lieu of being carried on each student.

Pursuant to the invention, the sensor 18d accesses personal identification data with respect to each student entering the vehicle and inputs such data to the processor 12d for comparison with identification data stored in the memory 14d and confirmation of the identity of students who are authorized to board the vehicle.

In the event an unauthorized student attempts to enter the vehicle, the processor 12d is programmed to communicate with the

central station 22d which, in turn, will verify any overriding authorization for the student's presence through a telephone link 29d with officials at a school 30d and/or telephone communication with the home of the student for parent authorization. Once such authorization is obtained, the central station will communicate with the processor 12d to program such student's identity parameters in the memory 14d either on a temporary override or permanent basis.

The processor 12d also stores in the memory 14d an attendance record of all students carried on the vehicle with such information being transmitted to the school 30d through the central station 22d.

The sensor 18d additionally obtains personal identification data of each student exiting the vehicle for comparison with the trip attendance record maintained in the memory 14d and verification that no students remain in the vehicle after the morning and afternoon drop off.

Pursuant to the invention, the sensor 18d is utilized to obtain the personal identification data of each student entering the vehicle for the return trip home and information received from the location determining device 16d is inputted to the processor 12d which then compares such information with location parameter

data stored in the memory 14d pertaining to the designated drop of point, e.g., home or local bus stop, of each student occupant of the vehicle.

Upon the processor detecting that the vehicle is about to enter the student's home area drop off point or local bus stop area, the processor 12d communicates to the central station 22d or directly communicates via an output device 20d such as, a cellular telephone system, to the respective student's homes 32d, 34d, 36d and 38d advising the student's parent and/or guardian that their child is about to be dropped off.

It should also be appreciated that the processor 12d can be programmed to utilize the output device 20d to communicate directly with a student's home upon detecting that an unauthorized student is boarding the vehicle. In such instance, the memory 14d would include home identification data pertaining to all students enrolled at the school 30d rather than only the students authorized for boarding the particular vehicle.

Additionally, all of the embodiments encompass the monitoring system processor 12, 12a, 12b, 12c and 12d transmitting sensor and/or location data to the central station processor 26, 26a, 26b, 26c and 26d which accesses parameter limit data stored in its

associated memory 28, 28a, 28b, 28c and 28d to determine if an out of boundary condition exists.

The central station processor may also access and download further data bases, e.g. state driver license restriction records, for determining boundary limits to be stored in its associated memory.

Thus it will be appreciated that there is provided a monitoring system which achieves the various aspects, features and considerations of the present invention and which is well suited to meet the conditions of practical usage.

Since various possible embodiments might be made of the present invention and since various changes might be made in the exemplary embodiments shown herein without departing from the spirit of the invention, it should be understood that all matter herein described or shown in the accompanying drawings should be interpreted as illustrative and not in a limiting sense.